CRUSH Project

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Ames Research Center, together with the Robert Mondavi Winery (Oakville, California) and Terra Spase Vineyard Consulting (Napa, California), is evaluating the use of geospatial technology (remote-sensing, geographic information systems) in a "precision agriculture" context. In the Canopy Remote-Sensing for Uniformly Segmented Harvest (CRUSH) project, high-spatial resolution multispectral images were collected at midseason 1997 with an airborne ADAR-5500 digital camera system.

In a technology demonstration, an image of a 7.5-acre Mondavi chardonnay study block was processed to a Normalized Difference Vegetation Index to improve sensitivity to grapevine canopy density. The Index values were then stratified and color-coded for visual discrimination. A georegistered output image was delivered to the winery for input to the grower's geographic information system. NASA and winery researchers field-sampled vines within the study block for canopy density (light interception), vine physiology (leaf-water potential, chlorophyll concentration), fruit characteristics (maturity, potential quality), and yield. The grower used a laptop computer with image display and onboard Global Positioning System to physically subdivide (with flagging tape) the study block for harvest based on vine vigor (high, medium, and low). Grapes from each field segment were fermented separately and the resulting wines were formally evaluated by the winery.

Field measurement of canopy density and leaf-water potential agreed well with image patterns of density, which was in turn related to grape maturity and malic acid concentration. Most significantly, the winery realized for the first time "reserve" wine (highest quality and value) from a portion of the study block. In addition to the technology demonstration, Ames staff transferred image processing methods and expertise to Terra Spase, who was then able to add value to the raw imagery and sell the product to some 25 North Coast wine-producing clients. Partially as an outcome of this project, Mondavi Winery has led an effort to establish the Wine Country Geographical Information System, a regional user group dedicated to sharing spatial data and processing techniques.

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Modeling Leaf and Canopy Reflectance

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The goals of this project are to build a leaf reflectance model (LEAFMOD) that incorporates the absorbance properties of biological chemical components, to test the validity of the model, and to evaluate the sensitivity of canopy reflectance to changes in leaf chemical composition by coupling the leaf model to a canopy model. This research will contribute to a better understanding of the radiative transfer processes of plant canopies and will be useful in interpreting remote-sensing data, that is, images from airborne and satellite platforms, used for ecological and biogeochemical research. The results should be useful in determining the minimum sensing requirements for future high-spectral-resolution instruments.

The LEAFMOD computer simulation program was developed to run in two modes: (1) a forward mode that simulates leaf reflectance and transmittance given the optical properties of the leaf material, and (2) an inverse mode that computes the optical properties given reflectance and transmittance by finding values that reproduce the observed reflectance and transmittance in forward mode. Tests of LEAFMOD confirmed that the model predicts realistic